NAVAL FACILITIES ENGINEERING SERVICE CENTER
Port Hueneme, CA 93043-4370

Technical Memorandum
TM-2351-ENV

SUMMARY RESULTS

2001 SURVEY OF DOD EVALUATION OF STORM WATER TREATMENT TECHNOLOGIES

Prepared by:

Brian Y. Shin
David Cook

Prepared for:

Puget Sound Naval Shipyard
Bremerton Office

September 2001

REPORT DOCUMENTATION PAGE	Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 2001	Final; March – April 2001

4. TITLE AND SUBTITLE

SUMMARY RESULTS – 2001 SURVEY OF DOD EVALUATION OF STORM WATER TREATMENT TECHNOLOGIES

5. FUNDING NUMBERS

6. AUTHOR(S)

Brian Y. Shin and David Cook

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Facilities Engineering Service Center
1100 23rd Avenue
Port Hueneme, CA 93043-4370

8. PERFORMING ORGANIZATION REPORT NUMBER

TM-2351-ENV

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Concurrent Technologies Corporation
510 Washington Avenue
Bremerton, WA 98337

10. SPONSORING/MONITORING AGENCY

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE
Approved for public release; distribution is unlimited.	

13. ABSTRACT (Maximum 200 words)

The Naval Civil Engineering Service Center (NFESC) surveyed various Department of Defense activities to determine if any of them have conducted demonstrations and evaluations of storm water treatment technologies. Of the 14 environmental contacts that NFESC contacted, only two had attempted to evaluate storm water treatment technologies.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Stormwater treatment technologies, wastewater systems survey, filtration, non-point sources	30
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
U	U	U	U

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std Z39-18
298-102

This page left blank.

Table of Contents

This page left blank.

1. INTRODUCTION

The Naval Facilities Engineering Service Center (NFESC) surveyed various Department of Defense (DOD) activities in order to determine if any of them have conducted demonstrations and evaluations of storm water treatment technologies. Of the 14 environmental activities that NFESC contacted, only two had attempted to evaluate storm water treatment technologies.

NFESC conducted this survey in cooperation with Concurrent Technologies Corporation's (CTC) Bremerton Office. CTC is working for Puget Sound Naval Shipyard (PSNS) on the National Defense Center of Environmental Excellence program "to address high priority environmental problems for the Department of Defense (DOD), other government organizations, and the industrial community." One of the environmental problems, which CTC is evaluating for PSNS, is pollution from storm water runoff from industrial areas. This survey is to help CTC determine whether any Navy, or DOD activities, have extensively studied the pollution reduction efficiency of any structural storm water treatment technologies or any non-structural best management practices (BMPs). This information will be used to help CTC identify storm water research needs.

2. APPROACH

This effort consisted of contacting environmental personnel at SPAWARSYSCEN, NFESC, various Navy installations, Air Force Center of Environmental Excellence (AFCEE), Army Environmental Center (AEC), and Army Corps of Engineers. To narrow down the number of Navy installations to survey for this study, NFESC relied on the results from a Navy-wide water and wastewater systems survey conducted on July 1999 by NFESC for the Chief of Naval Operations Shore Compliance Branch.

3. FINDINGS

3.1 Storm Treat™ Technology Evaluation by SPAWARSYSCEN

SPAWARSYSCEN has evaluated the StormTreat™ technology system, one of the technologies listed in CTC's own report, "Storm Water Needs Assessment and Technology, Nov 18, 1999." The StormTreat™ system is a modular treatment system that utilizes filtration, sedimentation, skimming, and biofiltration with the use of native species of bulrush grasses. Simply speaking, it is a wetland in a box.

The StormTreat™ system is located adjacent to a parking lot for Naval Base Point Loma, and is down-gradient to McClellan Road, which runs by Naval Base Point Loma. The land area that feeds into the treatment system is comprised of McClellan Road and adjacent areas, and is fairly steep and hilly, which allows sufficient gravity flow through the system. The treated storm water and any overflow are discharged directly into San Diego Bay. The State of California has listed San Diego Bay as "impaired" due to sediment toxicity, benthic effects, and levels of copper higher than established water quality standards. The causes of these impairments are from point sources and non-point sources.

SPAWARSYSCEN installed the StormTreat™ system in 1997, with the support of Naval Base Point Loma, to demonstrate StormTreat's effectiveness in semi-arid climates, document maintenance needs for this system, and as a proactive approach to addressing storm water pollution. Storm water flows into two 200-gallon cylindrical plastic basins, and each basin feeds to a set of two StormTreat™ tanks, for a total of four tanks on-site. Each tank is 10 feet in diameter and 4 feet in height. The tanks were planted with the native species of bulrush grasses *Scirpus acutus* and *Scirpus robustus*. To keep the plants alive during the dry seasons, each set of tanks has a sump pump powered by a solar panel on a pole, and water was added twice in 1999. A plastic liner was placed 1 foot below the surface of the pea gravel where the bulrushes grow so that water pumped to the surface would not flow immediately back down.

A number of problems were encountered and solved through this project, which could provide valuable lessons learned. One problem was that the site for the treatment system has possible archeological significance. This problem was solved by placing the system above ground and burying it behind a retaining wall filled with gravel. Another problem was that drainage patterns were not always self-evident and storm drain maps were not always accurate. This problem was solved with extensive site investigations including conducting smoke tests and observing the water flow as a fire fighter sprayed down the study area. Only one of the tanks had a slight problem with the bulrush dying, which could have been due to a slightly lower water level in that tank.

The final report for this evaluation is still pending. However, the study has shown that the StormTreat™ system has with statistical significance, lowered pollutant levels in storm water runoff for the parameters:

- Total petroleum hydrocarbon
- Unresolved complex mixture of petroleum hydrocarbon
- Total resolved hydrocarbon
- Extracted organic material
- Chemical oxygen demand
- Total kjedahl nitrogen
- Zinc

A good confirmation could not be reached for the following parameters:

- Total phosphorus
- Lead
- Cadmium
- Chromium
- Aluminum
- Total suspended solids

The total suspended solids results may have been influenced by high sediment loading due to erosion in the basin.

3.2 Tidally Influence Construction Wetlands Studied by NFESC

The Restoration Branch of NFESC has installed and studied tidally influenced constructed wetlands at Naval Amphibious Base, Little Creek. The constructed wetlands are two rectangular cells, totaling about 1.5 acres. It was built to determine if a constructed wetland in a tidal setting could improve storm water runoff water quality. The treatment efficiency for this wetland could not be determined, since the pollutant levels of the influent were at non-detect or at very low levels.

The source of the water for the wetlands is a channel, which drains runoff from a large area comprising of residential, commercial, and military/industrial zones. The area within and surrounding the 2,147-acre facility is highly developed with industrial, residential, recreational, and infrastructure land uses bordered on all sides except the Bay. The planimetered area of the drainage basin contributing to the wetland is 58.9 acres. The potential sources of pollutants were identified as

- Stormwater runoff from the drainage area
- Amphibious Base landfill seepage
- Demineralizer pond

Check valves were installed at the entrance and exit of the wetland so flow through the wetland would be one-way, and flush through the system driven by the rise and fall of the tides, twice daily on average. The wetland was planted with salt-tolerant species including *Spartina* species.

This study, as mentioned, was not able to determine treatment efficiency. Investigation of metals in surface soil/sediment did yield interesting results, however. Generally, metals concentrations in sediment during the active growing seasons of late spring, summer, and early fall were lower than in the dormant seasons. The concentration of metals in plant tissues showed the opposite pattern: concentrations were higher during the active growing season. It is believed that *Spartina alterniflora* concentrates metals in its tissue from the rooted zones during active growth, but releases these metals as the plants go dormant in the fall. Analysis of samples included TCLP metals and TCLP volatiles and semi-volatiles s (including pesticides and herbicides.)

3.3 Existing Storm Water Systems Not Evaluated at Navy Locations

NFESC did not find any other Navy or DOD studies on storm water treatment technologies. However, NFESC was able to determine from a July 1999 Navy-wide Water and Wastewater Systems Survey, that out of 181 activities and installations, only 14 had reported using a form of storm water treatment technology. NFESC contacted a few of these installations and the findings are presented below.

3.3.1 Submarine Base, Bangor (SUBASE Bangor)

SUBASE Bangor has about three oil water separators and five detention ponds. The three main ponds are roughly 900 cubic yards in size. The parameters measured for these ponds are:

- Total suspended solids (TSS)
- Aluminum
- Iron
- Zinc
- Copper
- Lead
- Chemical oxygen demand (COD).

pH is monitored on one detention pond. SUBASE Bangor consists of light industrial areas, housing, and undeveloped areas. There are several outfalls that do not go through these detention ponds, but all of the light industrial areas do. SUBASE Bangor has not conducted any studies regarding structural or non-structural BMPs; however, has noticed that construction BMPs such as silt fences and hay bales have visually improved water quality.

3.3.2 Naval Air Engineering Station (NAES) Lakehurst

NAES Lakehurst has two equalization basins that treat a combination of storm and process water from the catapult testing area and aircraft arrestor area. The basins are in place as required by the state of New Jersey. The facility is located within sensitive pinelands, with groundwater just 6 feet below ground surface. The area treated is a 4- to 5- acre land with a 12,000-foot feet runway, and is entirely paved over. The systems' treatment capability includes equalization (200,000-gallon capacity), small oil water separators (for final polishing), and is discharged to a local stream. The systems are automated, with an adjustable detention time. Each system has a throughput of about 275 gallons per minute. The parameters and limits for these systems are:

Parameter	Limits
pH	5.5 - 7.5
Temperature	30°C
TSS	10 - 20 ppm
COD	100 ppm
Iron	no limit
Chromium (Total)	100 ppb
Zinc	1,000 ppb
Copper	1,000 ppb
Total Petroleum Hydrocarbon (TPH)	10 ppm

ppm = parts per million; ppb = parts per billion

3.3.3 Naval Air Station (NAS) Brunswick

NAS Brunswick has six detention ponds, which they believe is working well, but has maintenance problems stemming from an active beaver population. The Maine Department of Environmental Protection requires these ponds, as part of the State's Coastal Zone Management Act Program. The ponds vary in size from 1 acre to the natural 15-acre pond. The ponds treat runoff from about 4,500 acres, 40% of which are light industrial. The southern end of the Base is undeveloped. NAS Brunswick has not studied the effectiveness of these ponds, but may in the future if required by the Department of Environmental Protection. The parameters monitored for are:

- Petroleum aromatic hydrocarbon (PAH)
- Biological oxygen demand (BOD)
- Total suspended solids

3.3.4 NAS Patuxent River

NAS Patuxent River uses oil water separators to treat storm water runoff. Other measures NAS Patuxent River takes to prevent storm water pollution are not treatment technologies, but management measures such as riparian buffers and shoreline protection.

3.3.5 Commander Naval Region Mid-Atlantic (CNR MIDLANT)

CNR MIDLANT has several installations that use oil water separators (for example, at wash racks) but have not done any effectiveness studies. MIDLANT activities have only taken quarterly storm water samples to comply Virginia's Department of Environmental Quality monitoring requirements. The MIDLANT installations use non-structural BMPs to minimize storm water contamination, such as sweeping.

3.3.6 Naval Surface Warfare Center (NSWC) Crane

NSWC Crane has sedimentation basins at two heavy equipment racks, which collect solids and heavy dirt from vehicle washing. NSWC Crane also has sedimentation basins below a demolition range. The basins are located at the base of the hill where ammunition is detonated. NSWC also uses filters, fabric fences, and bales of straw to minimize erosion and storm water contamination.

3.3.7 Other Navy Installations with Storm Water Treatment Systems

NFESC attempted but was not able to contact the following installations:

- Naval Surface Warfare Center Carderock Division (NSWCCD), Bayview Detachment, Idaho (Treatment System Unidentified)

- NSWCCD Carderock, West Bethesda, Maryland (Storm Water Settling Ponds)

- NSWCCD Memphis Detachment, Florida (Storm Water Settling Pond)

- Naval Undersea Warfare Center, Newport Division, Rhode Island (Detention Basins, Natural Wetlands, Oil Water Separators)

- Fleet Industrial Supply Center Puget Sounds, Washington (Oil Water Separators)

3.4 Telephone Conversations

3.4.1 Air Force

NFESC spoke with contacts at the eastern, western, and central regions of the Air Force Center of Environmental Excellence (AFCEE). The people we spoke to were not aware of any studies to determine the effectiveness of BMPs or storm water technologies. The contact from AFCEE Central Region stated that installations implement BMPs in order to comply with management plans and permitting requirements, but do little in the way of documenting the BMP effectiveness.

3.4.2 Army

NFESC spoke with people at the Army Environmental Center and at the Army Corps of Engineers. The contacts indicated that the Army uses recommended BMPs to address storm water issues. The Army has no documented studies. The Army's approach is to develop watershed protocol based on information from the field. Treatment technology can be expensive and often requires maintenance. The goal is to prevent storm water contamination in the first place. For example, if there is runoff from a range, they develop a strategy to control this runoff or runoff from other sources in the watershed. As a rule, Army installations conduct an evaluation based on the given watershed information and do what makes sense.

Army concerns for storm water technologies include lack of O&M funds and human resources for maintenance and the extra effort for training. For future studies, AECs suggested topics are:

- Controlling mercury from air deposition (a widespread problem)
- Constructing wetlands
- Correct piping into storm water

Other Army agencies that may be studying the feasibility of these technologies are:

- U. S. Soil Conservation Service
- Waterways Experiment Station, Mississippi
- CREEL Cold Region Environmental Research Lab
- EPA Research Labs

Again, the Army's goal is to eliminate discharge. The Army is leading an effort to evaluate watersheds. Five installations will participate (includes 2 Army, 1 Navy, 1 Marine Corps, and 1

Air Force). Each installation will be reviewed and evaluated. The resulting documentation will provide a protocol process for other bases.

Army Corps of Engineers (ACE), Western Region, indicated that they do not have any data because their current permit only requires BMPs to be installed and there is no monitoring program. However, this year's state permit is now undergoing public review and will require a monitoring program if the nearby body of water is a designated impaired body of water.

As far as identifying the correct BMPs, the current practice is to use the San Francisco Regional Water Quality Control Board's Field Manual on Erosion and Sediment Control. This Field Manual can be ordered for about $50 at (510) 464-7900 (Friends of the SF Estuary). Further information on how this manual is used can be obtained from an erosion workshop given every year. For more information about this workshop, check their web site at http://www.abag.ca.gov/bayarea/sfep/programs/construction/index.html. The best source of current erosion control technologies is the International Erosion Control Association at http://www.ieca.org/index_conference.html. ACE will be specifying "tackified straw" as the default erosion BMP and "fabric rolls" as the default sedimentation BMP in all of their construction contracts.

3.5 Other Potential Sources of Information

NFESC did not find any other information sources for DOD studies on storm water treatment technologies or best management practices. The Chief of Naval Operations has a contractor developing a table of Best Management Practices. However, the table is just a compendium of existing BMPs and does not include information on treatment efficiencies (see Appendix A) Organizations outside DOD that have put together information on effectiveness of storm water treatment technologies include the Urban Water Resources Research Council (UWRRC), http://www.bmpdatabase.org, and, as recommended by NAS Patuxent River, the Center for Watershed Protection http://www.cwp.org.

The UWRRC in a cooperative agreement with the Environmental Protection Agency has compiled over 90 BMP studies conducted over the past 15 years. The database compiled allows querying by BMP type, BMP group, or by contaminants removed.

The Center for Watershed Protection is a non-profit, non-membership organization established to assist local governments in 30 states and the District of Columbia to:

- Understand and define the relationship between urban growth and the degradation of watersheds.
- Link specific land uses to water quality.

- Educate public and private sectors about the need for greater protection of our waters through watershed protection.

- Advise communities on the most reliable and effective ways to protect and restore watersheds over the entire development cycle.

- Bring together new approaches to watershed management by promoting technology-transfer and professional dialog.

Of possible interest is their publication *National Pollutant Removal Performance Database – 2000 – 2nd Edition.* This publication contains "summaries of more than 135 urban pollutant removal monitoring studies. It includes a statistical and graphical comparison of removal rates for six groups of storm water management practices: ponds, wetlands, open channels, filters, infiltration and on-site devices. In addition, key research gaps in terms of parameters and practices are identified."

4 CONCLUSION

NFESC found two studies DOD-wide dealing with storm water treatment technologies and BMPs: SPAWARSYSCEN found favorable results from StormTreat™ tank system and NFESC Restoration Branch discovered an interesting cycling of metals concentration in a constructed tidally influenced wetland. All the activities contacted indicated that they comply with permit requirements and implement needed BMPs, but have not conducted special studies to identify effectiveness of the BMPs. The few installations that have treatment technologies for storm water have fairly simple systems such as detention ponds and oil water separators.

Various Army and Air Force personnel contacted in the survey indicated that they have no knowledge of studies regarding treatment technology, and that their installations comply with storm water management plans and permits. The Army has expressed concerns about installing storm water technologies due to lack of operations and maintenance funds, lack of human resources for maintenance, and the extra effort required to train personnel on managing these systems. No Marine Corps personnel were contacted for this survey, since the Marine Corps relies on the Navy to provide environmental and engineering support.

APPENDIX A

BEST MANAGEMENT PRACTICES FOR IMPLEMENTING AND COMPLYING WITH THE CLEAN WATER ACT

INTRODUCTION

Best Management Practices (BMPs) can be used to protect waterbodies from contaminated runoff associated with events such as spills, construction, maintenance activities, daily facility operations, and other activities. Specifically, BMPs serve as useful tools in implementing and complying with CWA initiatives such as the Total Maximum Daily Load (TMDL) and storm water programs. In addition, BMP implementation provides a step-by-step method for improving water quality by focusing on local impacts first.

This document contains a listing of three types of BMPs: structural, nonstructural, and preventive maintenance BMPs for storm water runoff.

1. Structural BMPs typically require construction or development of a separate structure, such as an oil-water separator, to achieve desired results.

2. Nonstructural BMPs can be implemented into daily programs with minimal effort and often at low cost.

3. Preventive maintenance BMPs can be implemented to prevent contamination of storm water; the list is based on a review of activity storm water discharge permits.

Note: This document is just a partial listing of the commonly used BMPs and does not contain all of the BMPs that currently exist. However, as more information becomes available on other BMPs, this document will be updated and posted on the CWASSC website: http://www.denix.osd.mil/denix/DOD/Working/CWASSC/.

This page left blank.

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Submerged Aquatic Vegetation	Erosion Control, Sediment Control	Submerged aquatic vegetation consists of grasses, particularly vascular plants that grow completely underwater. These plants filter and trap sediment that can cloud the water column, protect shorelines from erosion by minimizing wave action, and remove excess nutrients.	The Chesapeake Bay Program Homepage http://www.chesapeakebay.net/info/baygras.cfm
Silt Fences	Erosion Control, Sediment Control	Silt fences are appropriate immediately upstream of the site's point of runoff discharge before flow becomes concentrated. (Maximum design flow rate should not exceed 0.5 cubic feet per second.)	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-52 Appendix B, BMP Fact Sheets, B-1 http://www.epa.gov/owm/sw/conguide/
Check Dams	Erosion Control, Sediment Control, Flow Diversion	Check dams are appropriate for use across swales or drainage ditches to reduce the flow velocity, or in cases where velocity must be reduced because a vegetated channel lining has not yet been established.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-65 Appendix B, BMP Fact Sheets, B-13 http://www.epa.gov/owm/sw/conguide/
Earth Dike	Erosion Control, Sediment Control, Flow Diversion	Earth dikes can be used to divert upslope flows away from disturbed areas, divert runoff to a stabilized outlet to reduce the length of the slope the runoff will cross, and direct sediment-laden runoff to a sediment-trapping device.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Appendix B, BMP Fact Sheets, B-15 http://www.epa.gov/owm/sw/conguide/

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Drainage Swale	Erosion Control, Sediment Control, Flow Diversion	Drainage swales can be used to divert upslope flows away from disturbed areas and divert runoff to a stabilized outlet. Drainage swales can also reduce the length of the slope the runoff will cross and direct sediment-laden runoff to a sediment-trapping device.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Appendix B, BMP Fact Sheets, B-17 http://www.epa.gov/owm/sw/conguide/
Grassed Swale	Erosion Control, Sediment Control, Flow Diversion	A grassed swale is an infiltration/filtration method that is usually used to provide pretreatment before runoff is discharged to treatment systems. Grassed swales are typically shallow, vegetated, man-made ditches designed so that the bottom elevation is above the water table to allow runoff to infiltrate into ground water. Grassed swales can also serve as conveyance systems for urban runoff and provide similar benefits.	Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, EPA-840-B-93-001c, January 1993. http://www.epa.gov/owow/nps/MMGI
Riparian Buffers	Erosion Control, Sediment Control, Pollutant Removal, Contaminant Removal	Riparian buffers counter the effects of pollutants by serving as filters, transformers, sinks, and sources. They also remove sediment and suspended solids from surface water runoff.	*Riparian Buffer Systems – The Basics*, June 14, 1999. http://www.ent.iastate.edu/ipm/icm/1999/6-14-1999/riparian.html
Stream Buffers	Erosion Control, Sediment Control	Stream buffers consist of a strip of vegetated land (of variable width) adjacent to a stream that is preserved from development activity to protect water quality, aquatic and terrestrial habitats.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Vegetated Filter Strips	Sediment Control, Pollutant Removal, Contaminant Removal, Organic Material Removal	Filter strips are located downslope from croplands and assist in removing sediments, nutrients, and pollutants from surface water runoff. Filter strips can be combined with stream buffers to protect the riparian corridor and help recharge groundwater sources.	**1)** *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, EPA-840-B-93-001c, January 1993. http://www.epa.gov/owow/nps/MMGI **2)** *Urban Best Management Practices for Nonpoint Source Pollution, Produced by the Point and Nonpoint Source Programs*, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Grassed Waterways	Erosion Control, Pollutant Removal, Contaminant Removal, Organic Material Removal	Grassed waterways, typically consisting of a perennial grass, provide for water disposal from terraces, diversions, or other concentrated flow areas. They also provide an area for channeling water without permitting soil erosion.	*Agricultural BMPs: Grassed Waterways*, Natural Resource Conservation Service, U.S. Department of Agriculture. http://www.al.nrcs.usda.gov/bmp/grassed.html
Windbreaks	Erosion Control	Windbreaks consist of rows of trees or shrubs used to protect the surroundings from wind. Windbreaks are a long-term conservation measure that may require twenty years to become functional. They are designed to prevent airborne sedimentation and provide a soil stabilization function.	*Northwest Ohio Windbreak Program*, Ohio Division of Forestry. http://www.hcs.ohio-state.edu/ODNR/Landownerasst/windbreak.htm
Constructed Wetland	Pollutant Removal, Contaminant Removal	Constructed wetlands aid in pollutant removal from water and are particularly appropriate where groundwater levels are close enough to the surface to provide the water supply necessary to sustain the wetland system. Large amounts of sediment loading can severely degrade the performance of the system.	**1)** *Preliminary Data Summary of Urban Stormwater Best Management Practices*, EPA-821-R-99-012, August 1999. Page 5-16 http://www.epa.gov/ost/stormwater/ **2)** *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, EPA-840-B-93-001c, January 1993. http://www.epa.gov/owow/nps/MMGI

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Infiltration Basin/Trench	Pollutant Removal, Contaminant Removal	Infiltration basins are designed to capture, hold, and infiltrate storm water runoff into the ground over a period of days. The basin or trench is a shallow excavated area backfilled with stone to create an underground reservoir. Storm water is diverted into the basin/trench and slowly infiltrates into the subsoil and eventually into the water table.	**1)** *Preliminary Data Summary of Urban Stormwater Best Management Practices*, EPA-821-R-99-012, August 1999. Page 5-9 http://www.epa.gov/ost/stormwater/ **2)** *Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Detention Basin	Erosion Control, Sediment Control, Pollutant Removal, Suspended Solids Removal	Detention basins are designed to temporarily contain a volume of storm water and release it shortly after the storm event. The ponds are normally dry between storm events and do not have any permanent standing water. These basins are typically composed of two stages: an upper stage, which remains dry except for larger storms, and a lower stage, designed for typical storms.	**1)** *Preliminary Data Summary of Urban Stormwater Best Management Practices*, EPA-821-R-99-012, August 1999. Page 5-10 http://www.epa.gov/ost/stormwater/ **2)** *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, EPA-840-B-93-001c, January 1993. http://www.epa.gov/owow/nps/MMGI
Retention Pond	Sediment Control, Pollutant Removal, Contaminant Removal	Retention ponds are designed to contain a volume of storm water runoff and provide storage and treatment of the runoff. Water in the pond is displaced above the permanent level. A fringe wetland can also be established around the perimeter of the pond.	**1)** *Preliminary Data Summary of Urban Stormwater Best Management Practices*, EPA-821-R-99-012, August 1999. Page 5-14 http://www.epa.gov/ost/stormwater/ **2)** *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, EPA-840-B-93-001c, January 1993. http://www.epa.gov/owow/nps/MMGI
Temporary Seeding	Erosion Control Sediment Control	Temporary seeding refers to the use of a short-term vegetative cover on disturbed sites that may be in danger of erosion. The purpose is to reduce erosion and sedimentation by stabilizing disturbed areas.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-14

Structural Best Management Practices (BMPs)

Structural BMP	**Type**	**Description**	**Source of Information**
Mulching	Erosion Control	Mulching can be used in areas where temporary seeding cannot be used due to temperature or climate.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-16 http://www.epa.gov/owm/sw/conguide/
Permanent Seeding and Planting	Erosion Control, Sediment Control	Permanent seeding of grass and planting of trees and brush stabilizes the soil by holding soil particles in place.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-20 http://www.epa.gov/owm/sw/conguide/
Preservation of Natural Vegetation	Erosion Control	Preservation of vegetation on a site should be planned before any site disturbance begins. This practice is used as a permanent control measure and is applicable to all types of sites.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-24 http://www.epa.gov/owm/sw/conguide/
Stream Bank Stabilization	Erosion Control	Stream bank stabilization is used where vegetative stabilization practices are not practical and where stream banks are subject to heavy erosion from increased flows or disturbance. Typical methods of stream bank stabilization include: riprap, gabion, reinforced concrete, log cribbing, grid pavers, and asphalt.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-28 http://www.epa.gov/owm/sw/conguide/

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Sediment Trap	Sediment Control	Sediment traps retain the runoff long enough to allow most of the silt to settle out. The trap should be large enough to allow the sediments to settle and should have the capacity to store the collected sediment until it is removed.	**1)** *Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-58 http://www.epa.gov/owm/sw/conguide/ **2)** *Urban Best Management Practices for Nonpoint Source Pollution, Produced by the Point and Nonpoint Source Programs*, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Gradient Terraces	Erosion Control	Gradient terraces are earth embankments or ridge-and-channels constructed along the face of a slope at regular intervals. They are constructed at a positive grade and reduce erosion damage by capturing surface runoff and directing it to a stable outlet at a velocity that minimizes erosion. Gradient terraces are usually limited to use on long, steep slopes with a water erosion problem, or where it is anticipated that water erosion will be a problem. They will be effective only where suitable runoff outlets are or will be made available.	**1)** *Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-70 http://www.epa.gov/owm/sw/conguide/ **2)** *Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Temporary Sediment Basin	Sediment Control	A temporary sediment basin is a settling pond with a controlled storm water release structure used to collect and store sediment produced by construction activities. Sediment basins can be designed to maintain a permanent pool or to drain completely dry. It is important to note that these basins should not be built on an embankment or in an active stream.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-60 http://www.epa.gov/owm/sw/conguide/
Multiple Pond Systems	Erosion Control, Sediment Control	Multiple pond systems are a cluster of ponds that incorporate redundant runoff treatment techniques within a single pond or a series of ponds.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Porous Pavement	Sediment Control, Nutrient Removal, Trace Metal Removal, Organic Matter Removal	Runoff is diverted through a porous asphalt layer into an underground stone reservoir. The use of porous pavement is constrained to deep and permeable soils, areas of restricted traffic, and suitable adjacent land uses.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Geotextiles (also known as road rugs, synthetic fabric or construction fabric)	Erosion Control	Geotextiles can be used alone as matting for flow stabilization on channels and swales or as separators between soil and riprap to prevent erosion beneath riprap and maintain a stable base.	*Storm Water Management For Construction Activities: Developing Pollution Prevention Plans and Best Management Practices*, EPA 832-R-92-005, September 1992. Chapter 3 -- Sediment and Erosion Control, 3-17. http://www.epa.gov/owm/sw/conguide/
Concrete Grid Pavement	Sediment Control, Pollutant Removal	Concrete grid pavement is an alternative to conventional and porous pavement that acts like an infiltration system. Concrete grid pavement can divert large volumes of potential surface runoff to groundwater recharge and reduce downstream flooding.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Sand Filters	Pollutant Removal, Nutrient Removal	Sand filters are a relatively new technique for treating storm water, whereby the first flush of runoff is diverted into a self-contained bed of sand. Runoff is then strained through the sand, collected in underground pipes and returned back to the stream or channel. Enhanced sand filters utilize layers of peat, limestone, and/or topsoil and may also have a grass cover. This practice is useful in watersheds where groundwater quality concerns prevent use of infiltration, and in urban areas with size restrictions.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Water Quality Inlets/ Oil-Water Separators	Sediment Control, Oil Removal	A water quality inlet is a three-chambered underground retention system designed to remove heavy particulates and small amounts of petroleum products from storm water runoff. As water flows through the three chambers, oil and grease separate from the storm water and are skimmed off and held in a catch basin or storage tank. The storm water then passes on to the storm sewer or into another storm water pollution control device. Oil water separators perform a similar function with oil skimmed off and contained in a storage tank while the water continues on to the sanitary sewer.	**1)** *Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm **2)** *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, EPA-840-B-93-001c, January 1993. http://www.epa.gov/owow/nps/MMGI
Vehicle Tracking Controls	Sediment Control	Vehicle tracking controls stabilize construction site entrances and usually consist of an asphalt or rock bed at least 50 feet long that separates construction areas from public roads. The asphalt or rock bed provides an area that removes loose sediment from vehicle tires.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm

Structural Best Management Practices (BMPs)

Structural BMP	**Type**	**Description**	**Source of Information**
Inlet Protection	Erosion Control, Sediment Control	Inlet protection consists of sediment filters around storm drain drop inlets or curb inlets. Construction activities may result in significant amounts of sediments entering storm drainage systems. Inlet protection should remain in place until the potential for erosion is minimal. Gravel-filled sandbags may be packed tightly around curb inlets or drop inlets to filter sediment from storm water before it enters a storm drain system. Straw bales or filter fabric may also be used if the situation allows for them to be entrenched.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Rough-cut Street Controls	Erosion Control	Rough-cut street controls are dirt berms or sandbag dikes used to prevent channel and gully erosion on unpaved surfaces. Controls are particularly essential on streets cut onto sloping surfaces. Controls route sheet flows off unpaved and unstable surfaces to stabilized swales along the sides of roads, other vegetated areas, or detention ponds. Controls should be installed at regular intervals along the road (especially sloping roads). Diversions should be placed closer as slopes become steeper.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Erosion Control Blankets	Erosion Control	Erosion control blankets are used in place of mulch on areas of high velocity/high runoff and/or on steep grades to control erosion on critical areas by protecting young vegetation.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm

Structural Best Management Practices (BMPs)

Structural BMP	Type	Description	Source of Information
Temporary Slope Drains	Erosion Control	Temporary slope drains are flexible or rigid conduits that extend from the top to the bottom of an erosion prone slope. Storm water is routed down the slope through the pipe to a stabilized outlet, preventing erosion of bare slopes.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Temporary Diversion Dike	Erosion Control	Temporary diversion dikes are, traditionally, ridges of compacted soil constructed at the top or base of a sloping disturbed area. Diversion dikes work by diverting runoff from unprotected areas or diverting sediment-laden runoff into a sediment-trapping facility. Planting vegetation on the dike will further reduce sedimentation.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Chemical Mixing Center (CMC)	Pollutant Control, Contaminant Control	CMCs provide a place where the operator can perform all operations where pesticides are likely to be spilled in concentrated form, or where even dilute formulations may be repeatedly spilled in the same area, over an impermeable surface. Surfaces should provide for easy cleaning and recovery of spilled materials. A CMC can be as simple as a concrete pad treated with a sealant and sloped to a liquid-tight sump where all of the spilled liquids can be recovered. For small spills, absorbents such as cat litter or sand may be used for spill clean up and then applied as a top dressing in accordance with the label rates, or disposed of as a waste. Solid materials can be swept up and reused.	Best Management Practices for Golf Course Maintenance Departments http://www.dep.state.fl.us/water/Slerp/Nonpoint_Storm water/agsrc/docs/golfbmp/chapter1.htm

Nonstructural Best Management Practices

Nonstructural BMP	Description	Source of Information
Good Housekeeping	Promptly contain and clean up solid and liquid pollutant leaks and spills including oils, solvents, fuels, and dust from manufacturing operations on any exposed soil, vegetation, or paved area. Alternatively, structural treatment BMPs can be used for dust-contaminated storm water, where warranted.	*Storm Water Management Manual for Western Washington*, August 2000. www.ecy.wa.gov/pubs/9914.pdf
Good Housekeeping	Sweep paved material handling and storage areas regularly as needed, for the collection and disposal of dust and debris that could contaminate storm water. Do not hose down pollutants from any area to the ground, storm drain, conveyance ditch, or receiving water unless the pollutants are conveyed to a treatment system approved by the local jurisdiction.	*Storm Water Management Manual for Western Washington*, August 2000. www.ecy.wa.gov/pubs/9914.pdf
Good Housekeeping	Clean oils, debris, sludge, etc. from all BMP systems, including catch basins, settling/detention basins, oil/water separators, boomed areas, and conveyance systems, regularly, to prevent storm water contamination.	*Storm Water Management Manual for Western Washington*, August 2000. www.ecy.wa.gov/pubs/9914.pdf
Good Housekeeping	Store liquids in containers, such as steel or plastic drums, that are rigid and durable, corrosion resistant to the weather and fluid content, non-absorbent, watertight, rodent-proof, and equipped with a tight cover.	*Storm Water Management Manual for Western Washington*, August 2000. www.ecy.wa.gov/pubs/9914.pdf

Nonstructural Best Management Practices

Nonstructural BMP	Description	Source of Information
Good Housekeeping	For temporary storage, place solid wastes contaminated with liquids or other potential pollutant materials into dumpsters, garbage cans, drums, or comparable containers that are durable, corrosion-resistant, non-absorbent, non-leaking, and equipped with either a solid cover or screen cover to prevent littering. If covered with a screen, the container must be stored under a lean-to or equivalent rain-protective structure.	*Storm Water Management Manual for Western Washington*, August 2000. www.ecy.wa.gov/pubs/9914.pdf
Good Housekeeping	In areas exposed to storm water, use containers, piping, tubing, pumps, fittings and valves that are appropriate for their intended use and for the contained liquid.	*Storm Water Management Manual for Western Washington*, August 2000. www.ecy.wa.gov/pubs/9914.pdf
Good Housekeeping	Institute a site recycling program. Improper waste management can increase pollutant loadings in runoff to surface waters and leaching to ground waters. Improper management of household hazardous wastes typically occurs due to unfamiliarity with proper disposal methods or lack of disposal alternatives.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Good Housekeeping	Ensure that litter is properly removed. Litter enters surface waters via wind and runoff events. Litter and yard wastes can clog storm water control and conveyance structures making the devices ineffective in control of pollutants transported by storm water.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Runoff Management	Direct runoff away from natural channels. Control of nonpoint sources can reduce the need for other management actions. Where possible, locate material stockpiles, access roads and other land disturbing activities away from critical areas such as steep slopes, highly erodible soils and areas that drain directly into sensitive water bodies. Direct runoff into management areas or sanitary sewers that are designed to remove sediment and/or other pollutants before discharging into surface waters.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Sediment and Erosion Control	Properly dispose of accumulated sediment. Sediment removed from traps and basins is often disposed of in areas lacking sediment controls. Without stabilization, such as seeding, these sediments may become re-suspended by storm water runoff or wind erosion.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Sediment and Erosion Control	Protect natural and riparian vegetation. Stripping of natural vegetation can result in increased sediment loadings in surface waters. Removal of riparian habitat and predevelopment flora	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of

Nonstructural Best Management Practices

Nonstructural BMP	Description	Source of Information
	and fauna results in decreased water quality. Results may include increased bank cutting, streambed scouring, siltation damage to flora and fauna, increased water temperatures, decreases in dissolved oxygen, and changes to the natural flow of streams or rivers. Riparian habitat stabilizes streambanks and aids in sediment control.	Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Pesticide Management	Ensure proper management and application of herbicides, pesticides, and fertilizers. Frequent or excessive applications of these chemicals can result in pollutant loadings in surface and ground waters. Discharges to surface or ground waters typically occur due to over application, improper application, or application during dormancy (useless application). Non-target plants or organisms are exposed both on-site and off-site through water transportation.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Runoff Management	Runoff that directly contacts stored materials or inventory can transport pollutants to surface or ground water. Reduce exposure to storm events by moving materials, products, devices, and manufacturing activities to an indoor location.	*Urban Best Management Practices for Nonpoint Source Pollution*, Produced by the Point and Nonpoint Source Programs, Water Quality Division, Wyoming Department of Environmental Quality, February 1999. http://deq.state.wy.us/wqd/urbbmpdoc.htm
Spill Prevention and Response	Mix and load pesticides over an impermeable surface (such as lined or sealed concrete) to collect and manage spills.	Best Management Practices for Golf Course Maintenance Departments http://www.dep.state.fl.us/water/Slerp/Nonpoint_Stormwater/agsrc/docs/golfbmp/chapter1.htm
Preventive Maintenance	Properly clean containers at industrial and commercial facilities by draining oil and fuel filters before disposal. Discard empty oil and fuel filters, oily rags, and other oily solid waste into appropriately closed and properly labeled containers.	*Storm Water Management Manual for Western Washington*, August 2000. Www.ecy.wa.gov/pubs/9914.pdf

Preventive Maintenance BMPs for Storm Water Runoff

Note: These BMPs were obtained from review of various approved Storm Water Discharge Permits. Coordinate with your State regulator and on-site coordinator to verify appropriateness and applicability prior to incorporation into existing plans or implementation at your facility.

1. Label all drums, cans, containers, tanks and valves
2. Restrict access to maintenance and equipment areas
3. Regularly clean facilities
4. Avoid using water to hose down site
5. Regularly sweep pavement areas
6. Control spills
7. Place trash receptacles at appropriate locations
8. Train employees to properly dispose of wastes
9. Permanently seal floor drains that discharge to the storm drain system
10. Construct a berm or dike around critical areas
11. Pave bermed areas
12. Recycle materials, as feasible
13. Store waste and recycling materials in proper containers and label accordingly
14. Limit significant materials inventory
15. Provide roof to cover source areas
16. Control roof downspout discharges
17. Minimize storm water run-on from adjacent facilities and properties
18. Reduce waste
19. Repair leaky roofs
20. Place portable rubber mats over storm drain inlets
21. Insert a filter in catch basins
22. Place absorbent blankets in catch basin
23. Routinely clean catch basins
24. Label storm drain inlets
25. Keep equipment and vehicles clean
26. Properly maintain equipment
27. Implement qualifying tests for equipment and vehicle operators
28. Conduct refresher courses in operating and safety procedures
29. Properly dispose of obsolete equipment, inoperable vehicles, and surplus materials
30. Check vehicles and equipment for leaks
31. Park vehicles on an impervious surface
32. Designate special areas for draining or replacing fluids
33. Drain all fluids prior to storing or salvaging vehicles and equipment
34. Completely drain oil filters before disposal
35. Wash equipment and vehicles in designated areas
36. Discharge wash water to sanitary sewer
37. Recycle pressure-wash solvents
38. Use drip pans under leaking equipment as a temporary measure until maintenance/repair can be performed
39. Perform equipment maintenance at designated areas
40. Designate areas for washing non-vehicular air filters and other greasy equipment
41. Conduct maintenance within a building or covered area
42. Reduce the amount of liquid cleaning agents used
43. Centralize liquid solvent cleaning
44. Substitute non-toxic or less-toxic cleaning solvents for more toxic products
45. Use solvents efficiently
46. Use outside contractor for handling used solvents and other significant materials
47. Protect storage containers from being damaged by vehicles
48. Properly store containers to prevent exposure of contents
49. Use overpack containers or containment pallets to store 55-gallon drums outside of storage areas
50. Use a "doghouse" design for outdoor storage of small liquid containers
51. Do not store used parts or containers directly on the ground
52. Store batteries in a secondary container
53. Do not allow open flames near flammable material
54. Use a door skirt or seal to prevent spills from spreading outside designated areas

Preventive Maintenance BMPs for Storm Water Runoff

55. Employ proper handling procedures to transport materials and waste
56. Store liquids and significant materials within a building or covered area
57. Provide overfill protection
58. Monitor major fueling operations
59. Provide absorbent booms in unbermed fueling areas
60. Eliminate the practice of topping off vehicle fuel tanks
61. Install leak detection systems
62. Designate areas for mobile tanker fueling
63. Restrict access to fuel tanks
64. Lock fuel tanks when not in use or on standby
65. Keep tanks, piping, and valves in good condition
66. Protect fuel tanks from being damaged by vehicles
67. Provide protection for permanent above-ground fuel tanks from firearm discharge
68. Enclose outdoor sanding and painting operations. Use tarps to contain and collect wastes
69. Vacuum particulate wastes around sanding or painting operations
70. Conduct indoor sanding and painting in an enclosed location
71. Avoid sanding or painting outdoors in windy conditions
72. Use efficient painting equipment
73. Do not empty toilet tanks during transit or while in port
74. Do not discharge bilge water in harbors
75. Use oil containment booms in the event of spills or leaks
76. Properly dispose of sediment generated by cleaning sanitary sewer lines
77. Eliminate treated wood products or use wood treated with less-toxic chemicals
78. Establish an integrated pest control program
79. Conduct pesticide operations under the supervision of a licensed applicator
80. Divert drainage to treatment facility/sanitary sewer
81. Divert drainage to a low-flow sump
82. Regularly inspect and maintain storm water conveyance systems
83. Regularly inspect and test equipment
84. Prepare appropriate spill prevention and response plans
85. Conduct personnel training regarding implementation of storm water pollution prevention at the facility
86. Provide adequate containment for storage of hazardous materials containers
87. Control dust and particulates
88. Do not pour or deposit waste into storm drains
89. Routinely report any observed non-storm water discharges